Evaluation of different perturbation approaches to provide initial and boundary conditions to a short-range LAM ensemble

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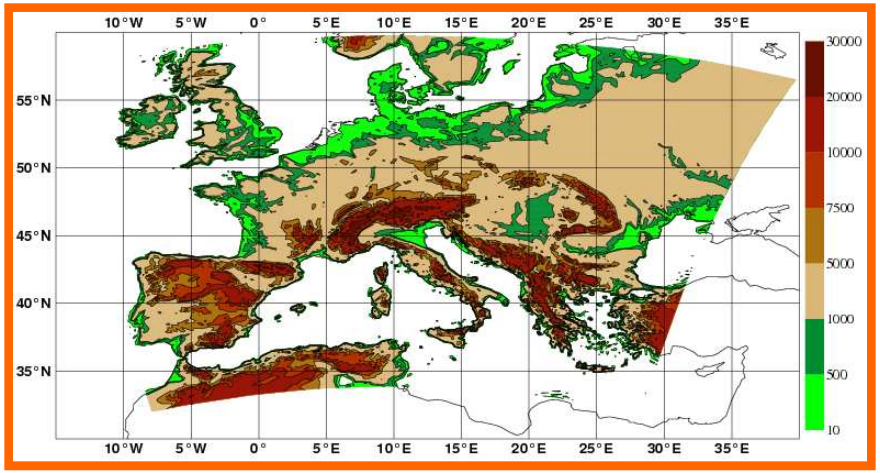
Aim of the work

- Part of the CONSENS Priority Project of COSMO
- Assess the validity of the multi-model approach to provide initial and boundary conditions to a LAM ensemble with respect to using a single model ensemble (EPS)
- Would a few global model runs be sufficient to provide the required amount of diversity to drive a LAM-EPS ensemble of 10-20 member size?
  - how the skill of the ensembles relates to the population?

COSMO-LEPS

- Downscaling of some selected members of the ECMWF EPS with the LAM COSMO
- Selection is made using a Cluster Analysis and Representative Member selection technique
- Perturbations of the model physics parameters are applied to the COSMO runs
- Operational since November 2002

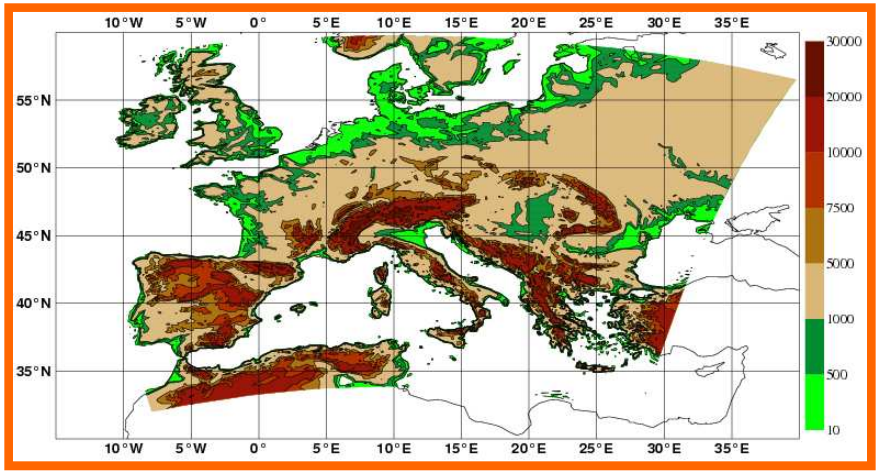
  - 12 UTC
  - 7 km, 40 levels
  - 16 members
  - 132 h



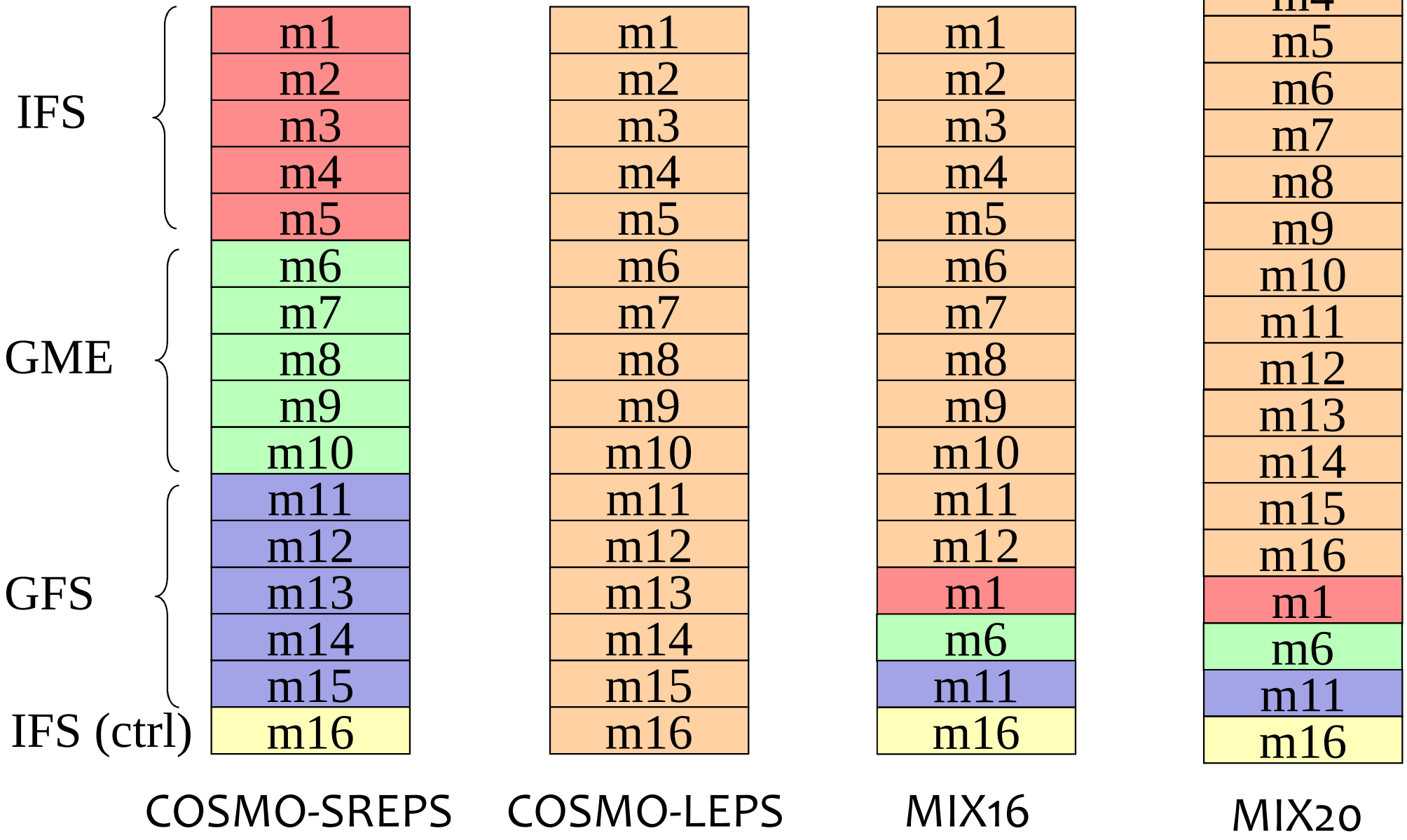
COSMO-SREPS

- Multi-analysis multi-boundary approach
- IC and BC are provided by 3 operational deterministic global models (IFS, GME, GFS)
- Perturbations of the model physics parameters are applied to the COSMO runs
- Running regularly since November 2010

- 00 and 12 UTC
- 7 km, 40 levels
- 16 members
- 48 h

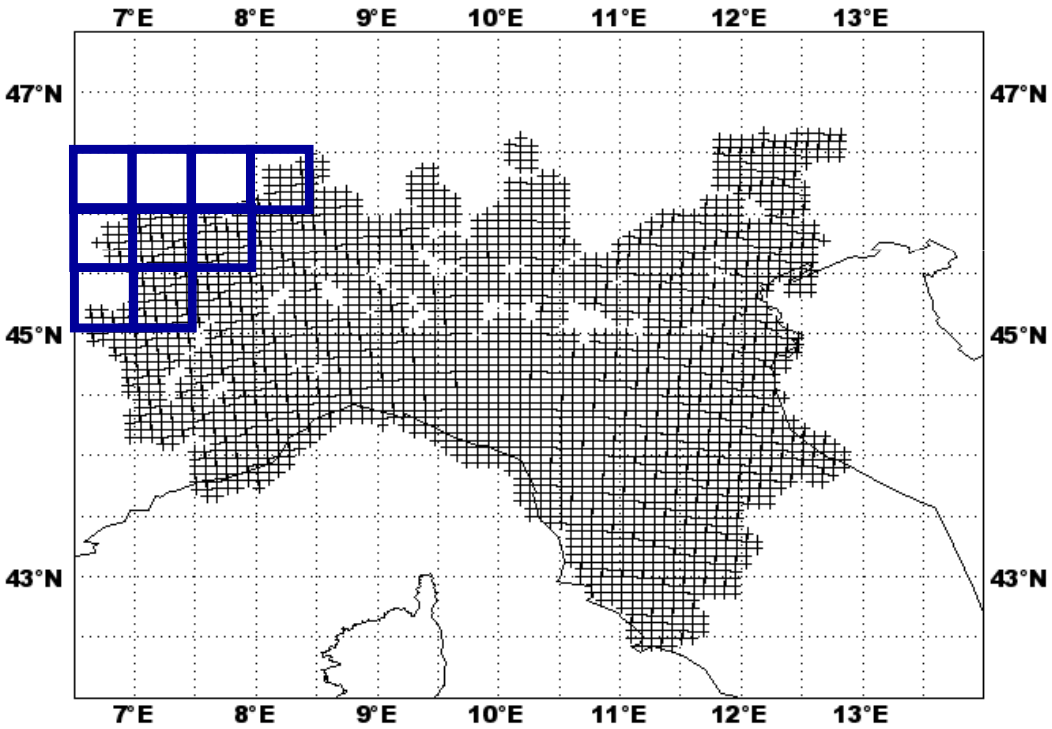


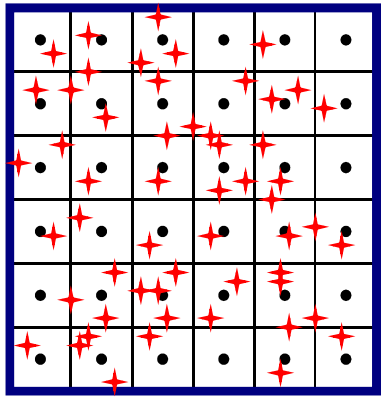
Ensemble mixing



Verification method

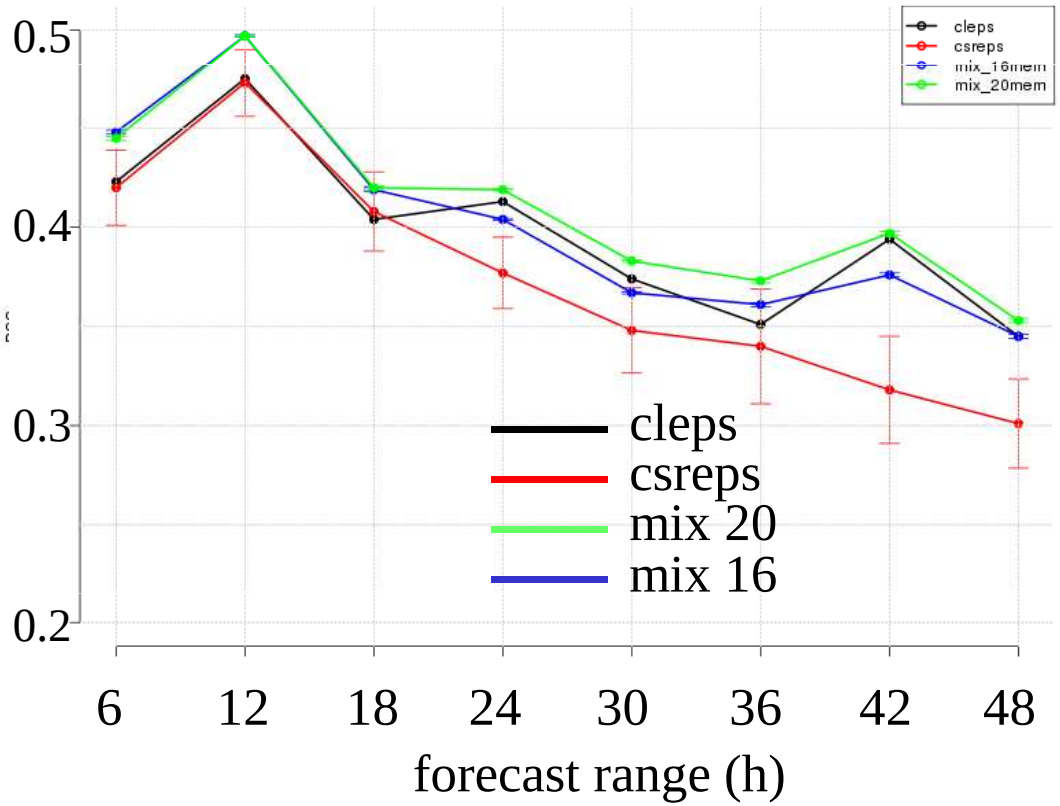
- Winter 2010/2011 (20 Nov 2010 - 28 Feb 2011)
- Northern Italy high-density network
- Average and maximum precipitation over boxes



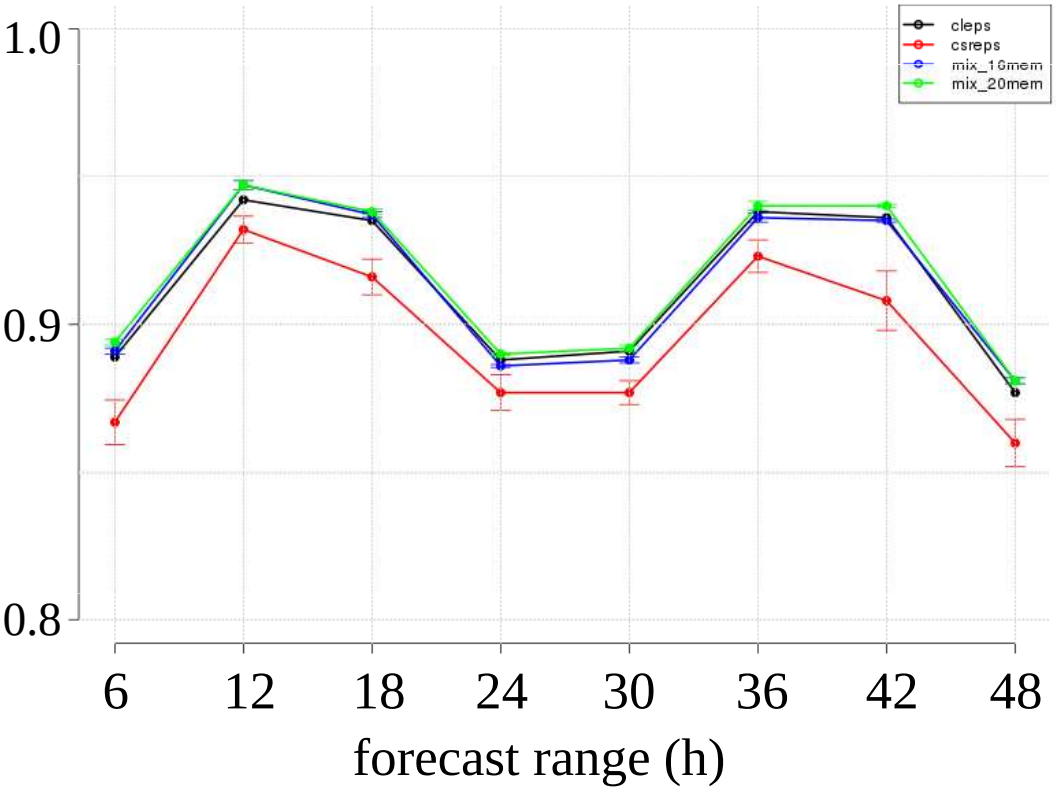


Comparison among ensemble generation techniques

BSS



ROC

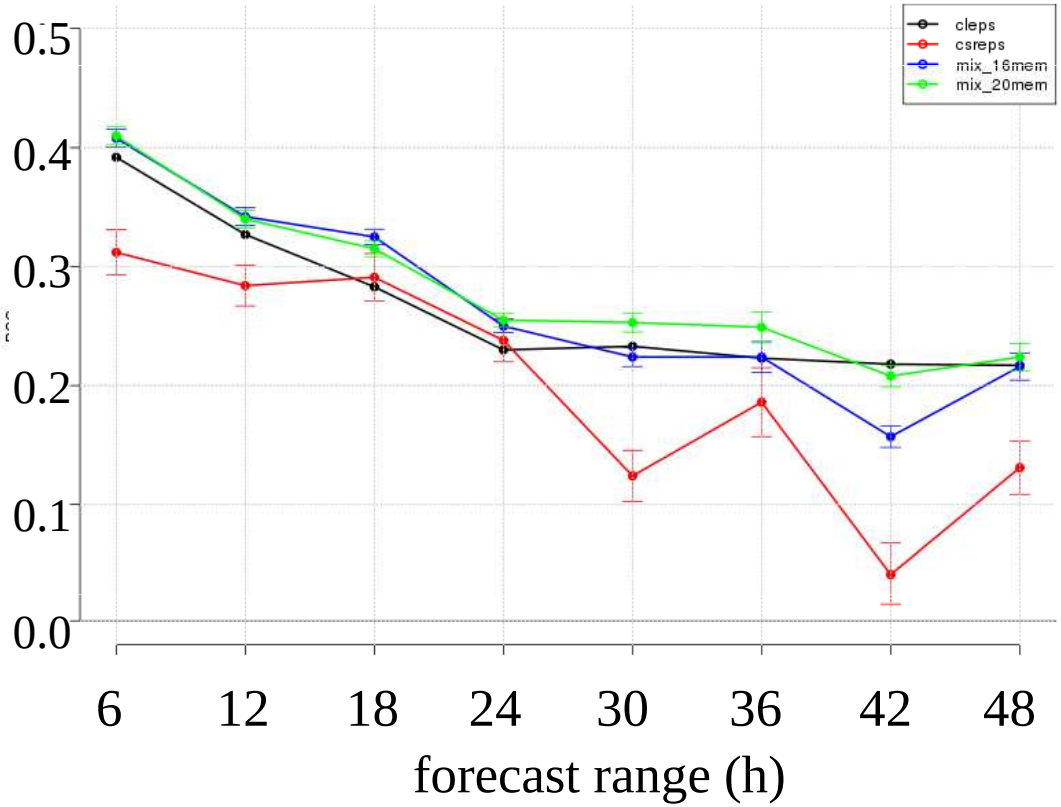


Average precipitation on 0.5 x 0.5 deg boxes > 1mm/6h

fc. range (h)	6	12	18	24	30	36	42	48
number of occurrences	563	502	529	618	577	465	511	584

Comparison among ensemble generation techniques

BSS



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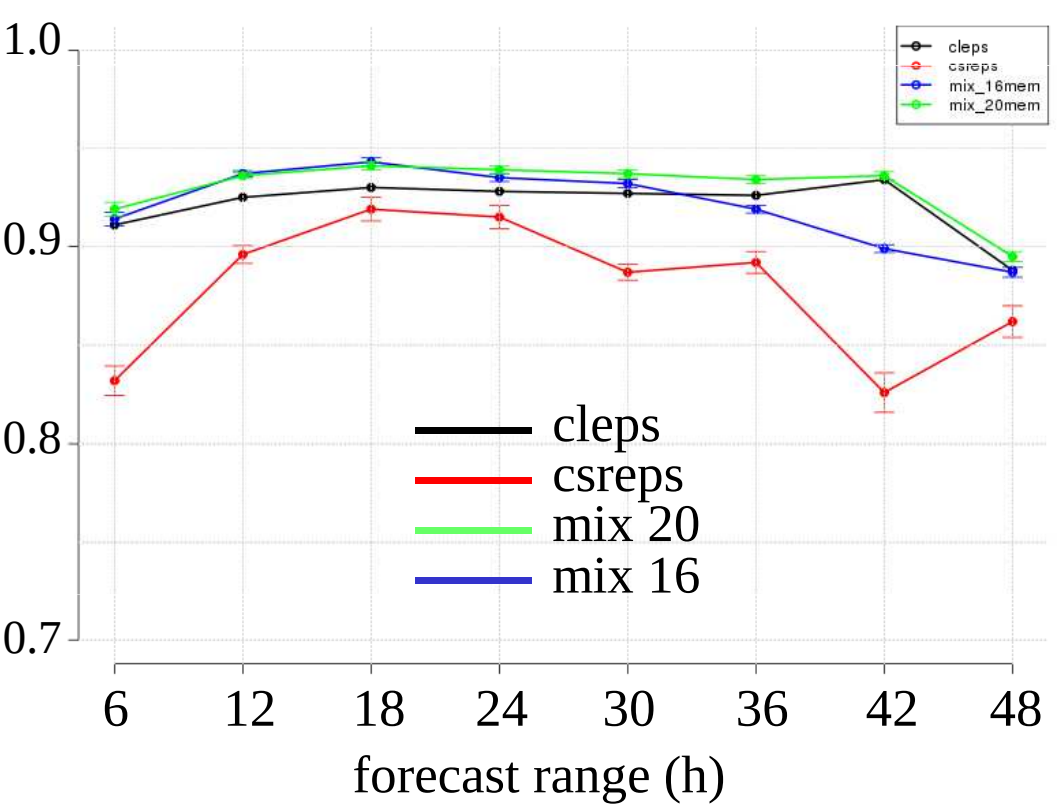
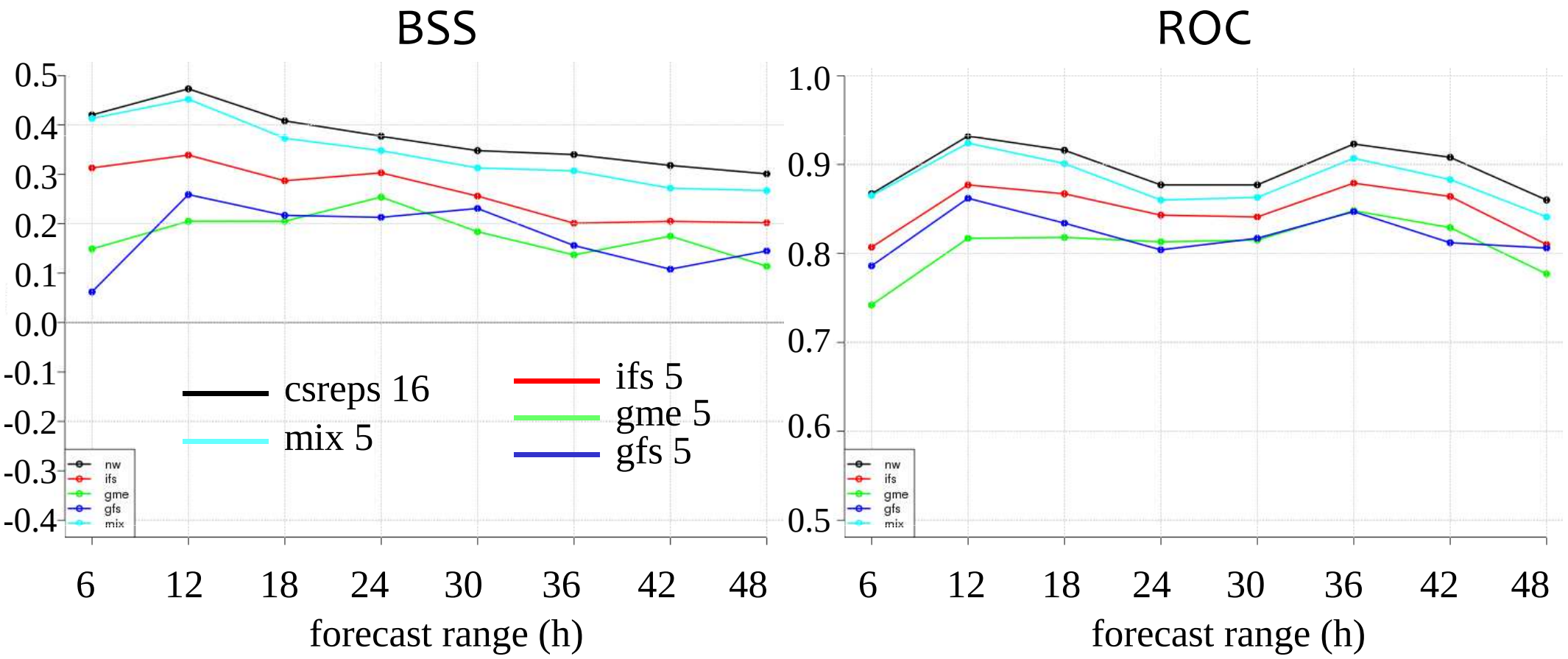


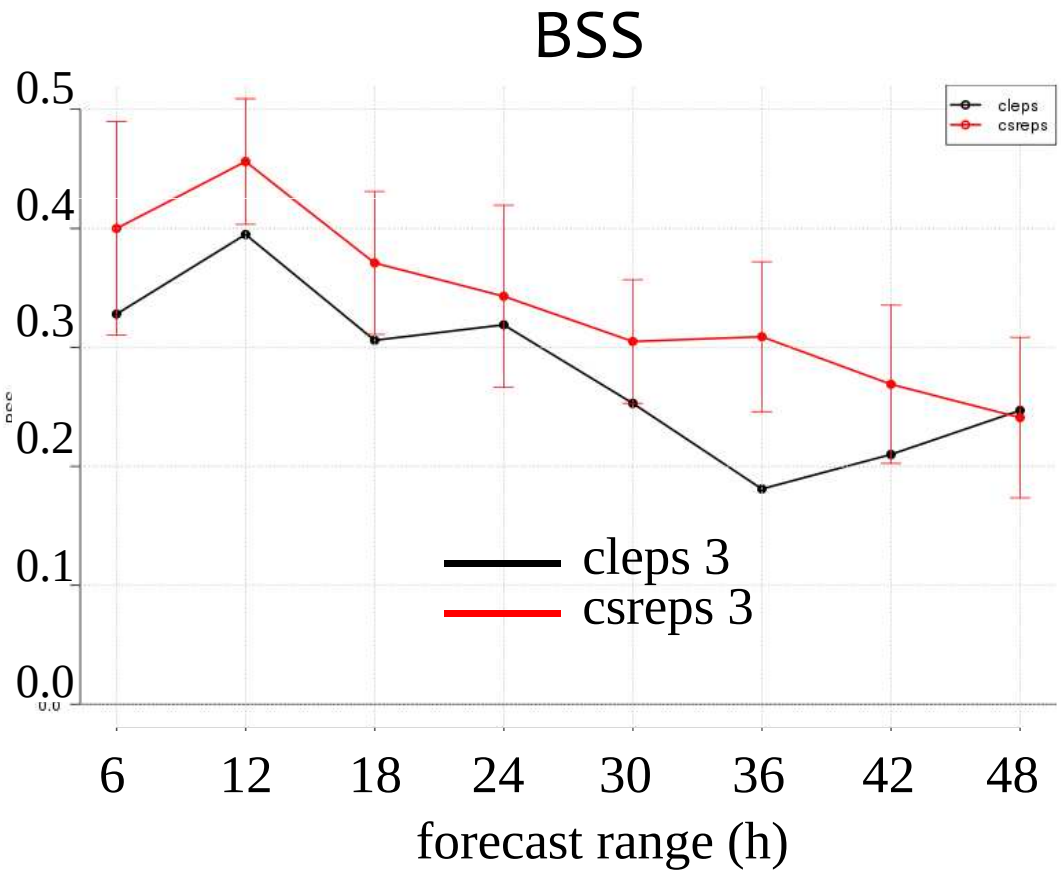
- COSMO-LEPS better than COSMO-SREPS for the short-range
- Mixing has a positive impact

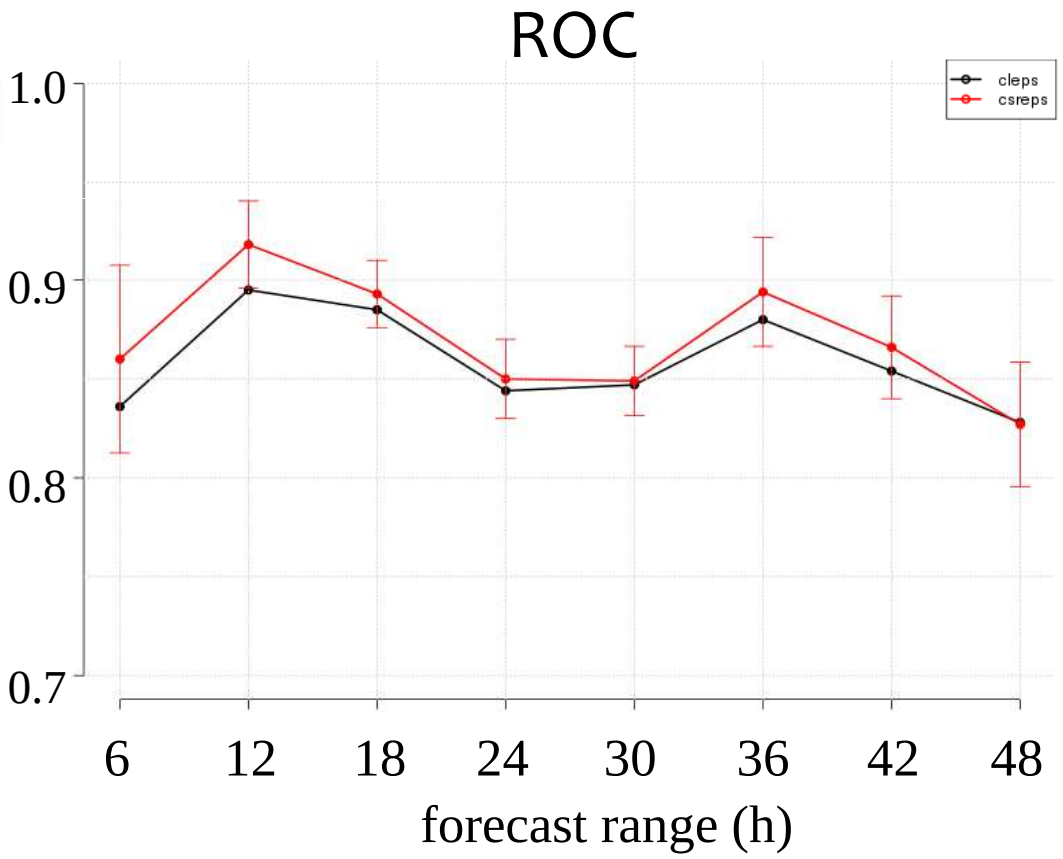
impact of the multi boundary approach



- Use of multi-model boundaries has a positive impact even if models have different qualities

boundary diversity wrt population





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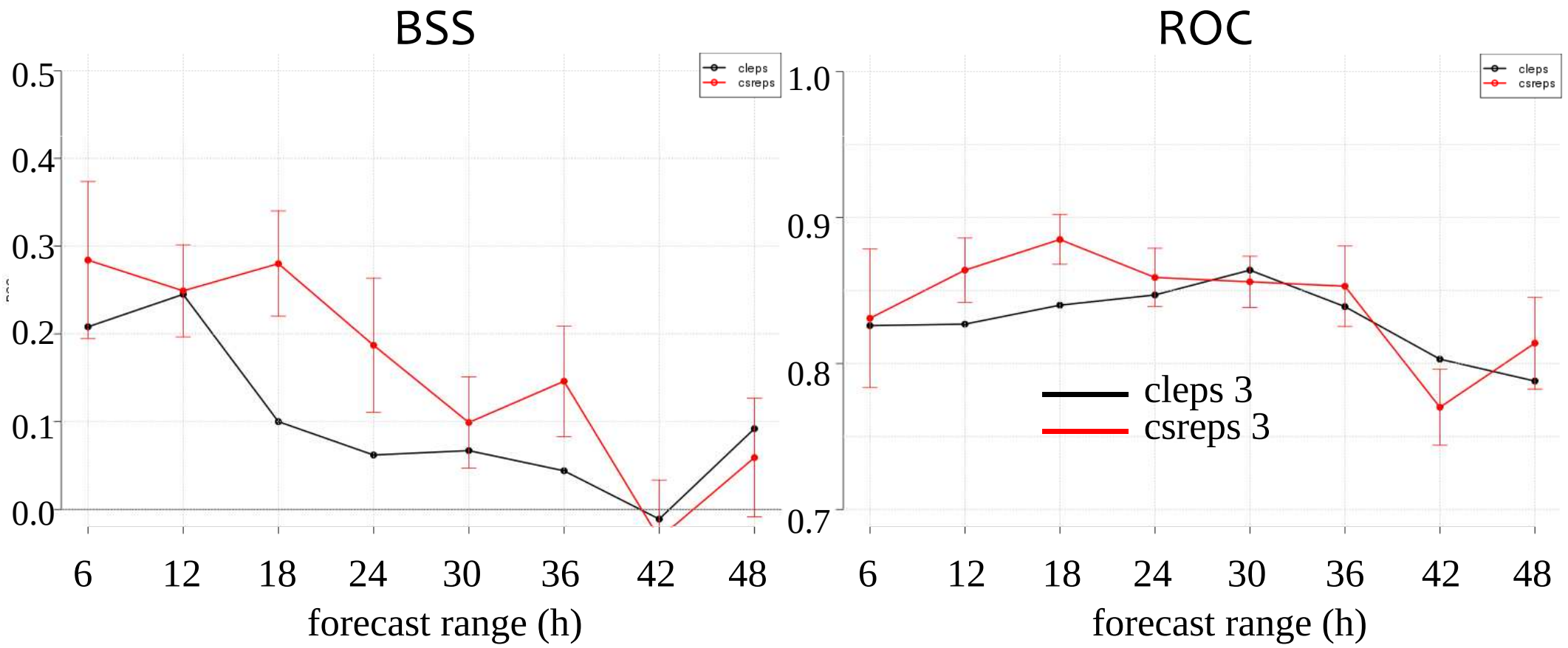
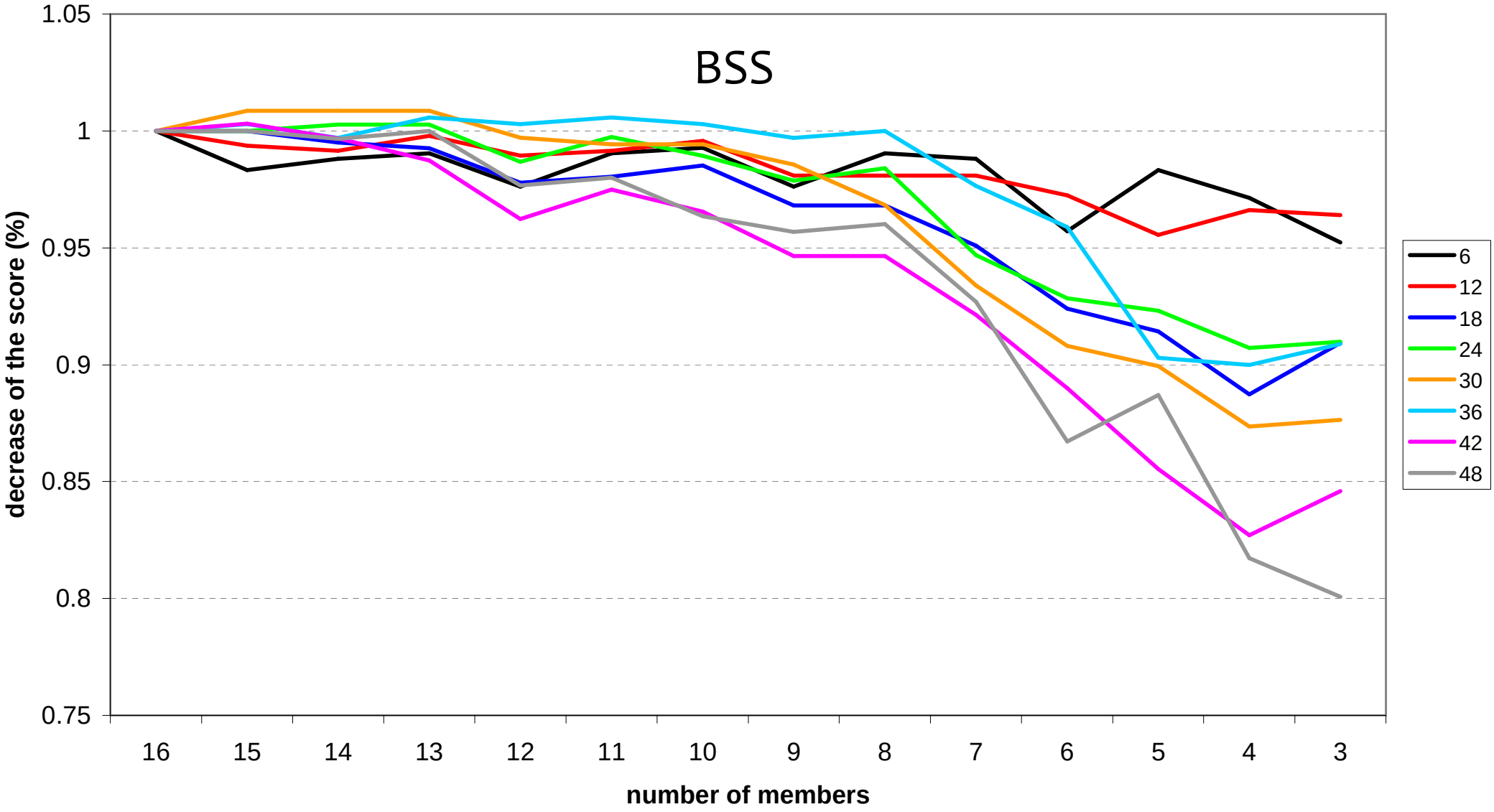
boundary diversity wrt population



- With multi-model boundaries several models are needed to get a performance similar (or better) to a downscaling from a well constructed ensemble (like EPS)

COSMO-SREPS
dependence on the ensemble size



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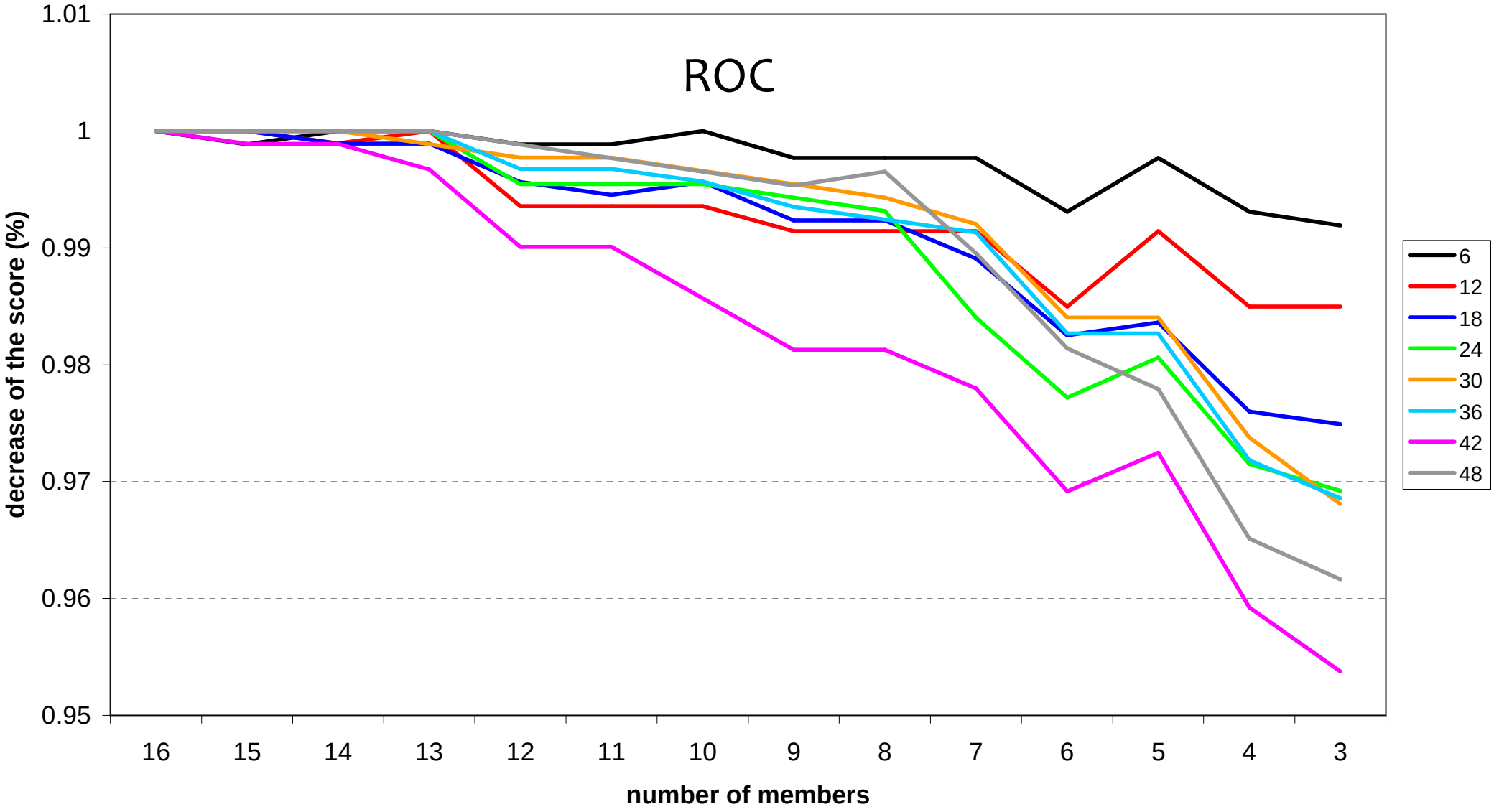

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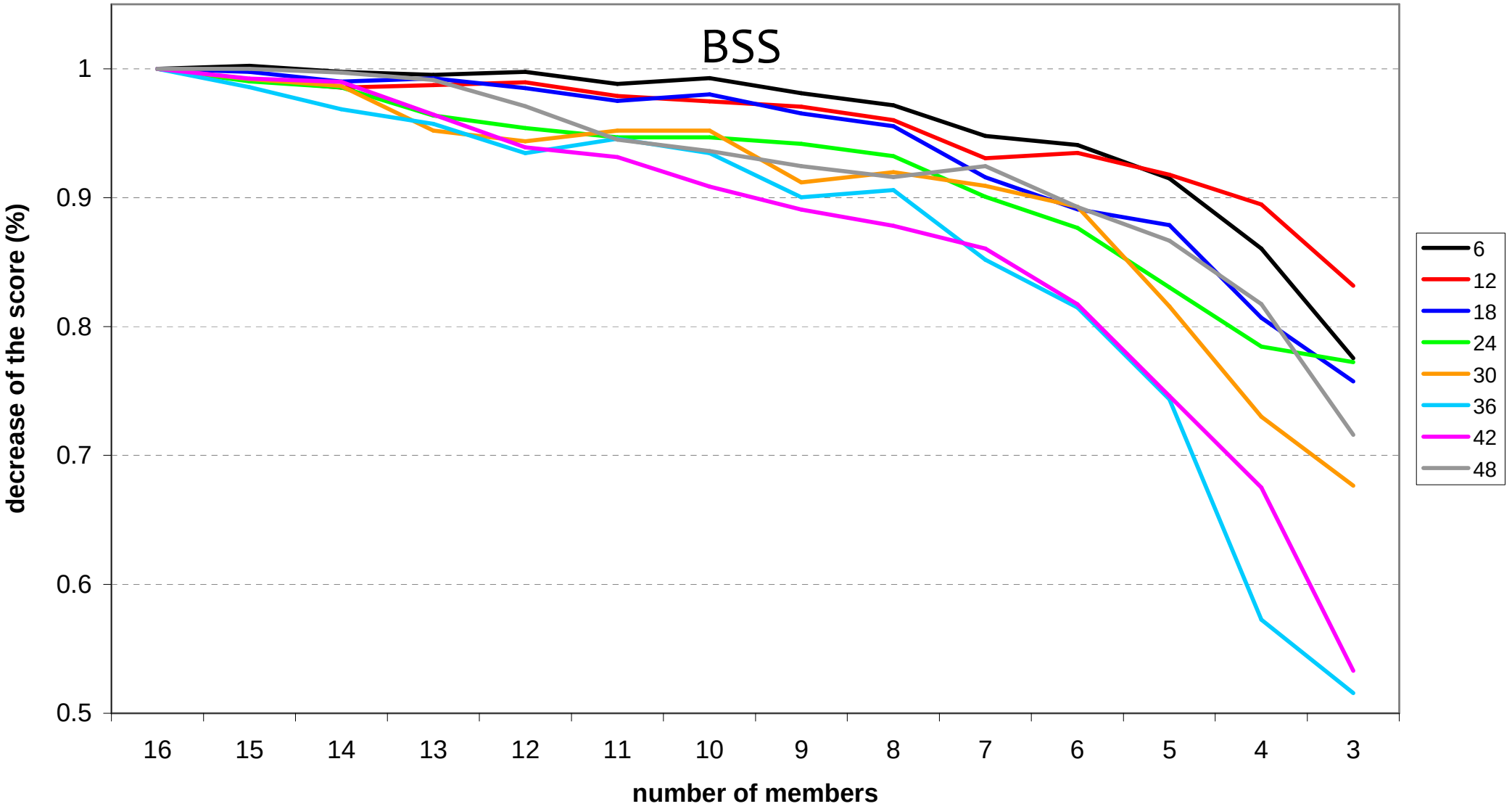
COSMO-LEPS
dependence on the ensemble size



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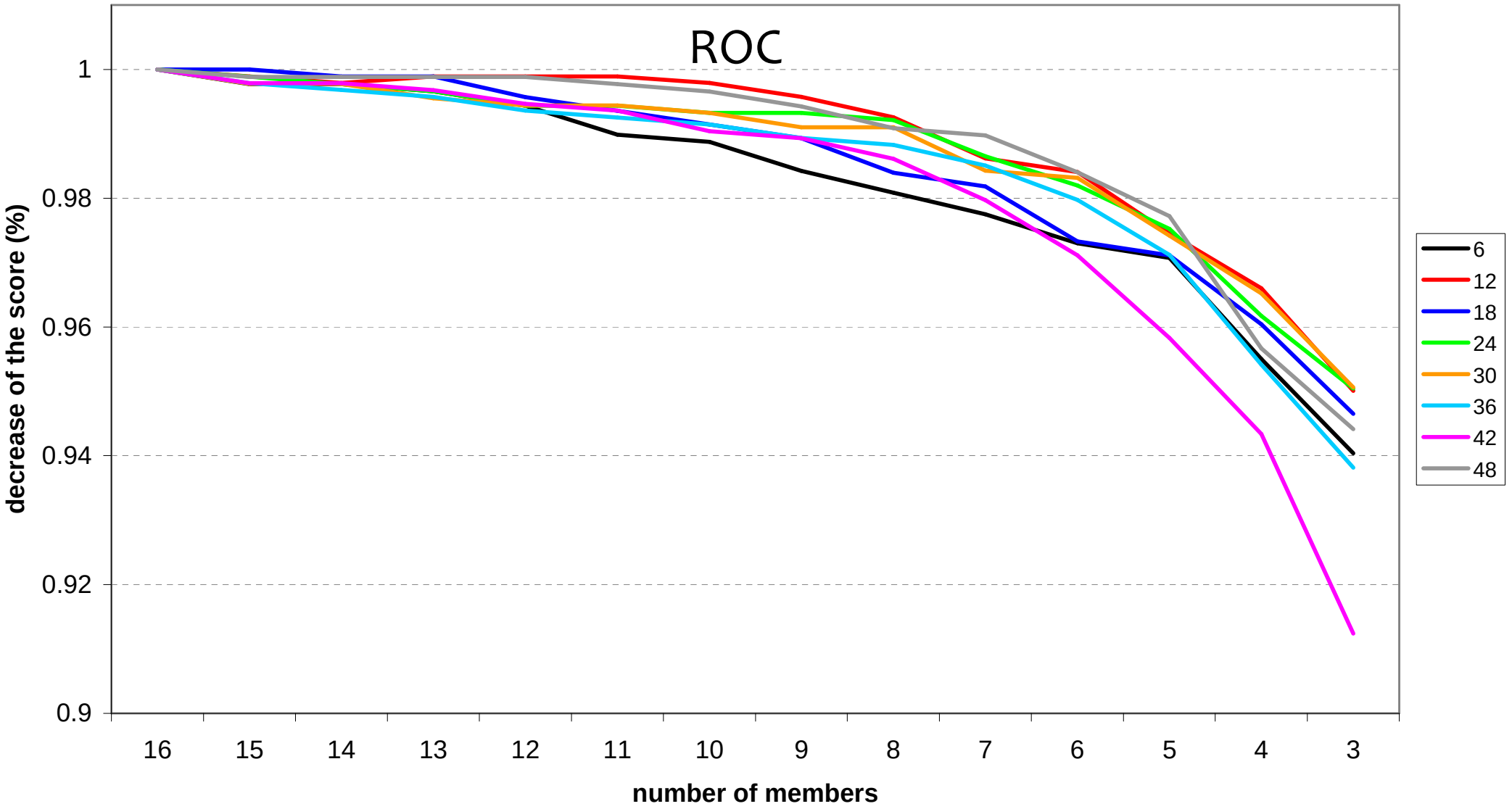

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Conclusions

- Generally COSMO-LEPS outperforms COSMO-SREPS
- The multi-model approach for i.c. and b.c. proves valuable even if model with different qualities are used
- For the multi-model approach to be effective, several models are needed to get a performance similar (or better) to a downscaling from a well constructed ensemble (like EPS)
- With only 3 global models providing initial and boundary conditions, the scores increase after 8 members is very limited
- the scores of both ensembles saturates around ensemble size 13-14
  - with a 16-member downscaling of the EPS we are already at the maximum attainable skill (in the short-range)

Future plans

- Stop running the extra COSMO-SREPS members (nested on the same sets of IC and BC but with different physics)
- merge the 16 COSMO-LEPS runs with 4 COSMO runs nested on available deterministic global model

COSMO-SREPS suite set-up

member	father	itype_conv	tur_len	pat_len	rlam_heat	rat_sea	crsmin
1	ifs	0	150	500	1	20	150
2	ifs	1	1000	500	1	20	150
3	ifs	0	500	500	0.1	20	200
4	ifs	1	500	500	1	1	150
5	ifs	0	500	2000	1	20	150
6	gme	0	500	500	0.1	20	150
7	gme	0	500	500	1	1	200
8	gme	0	500	500	10	20	150
9	gme	0	1000	500	1	20	150
10	gme	0	150	500	1	20	150
11	gfs	0	500	500	10	20	150
12	gfs	0	500	2000	1	20	150
13	gfs	0	500	500	1	60	150
14	gfs	0	500	500	1	60	50
15	gfs	0	500	500	1	20	50
16	ifs	0	500	500	1	20	150

convection scheme:

0 Tiedtke

1 Kain-Fritsch

maximal turbulent length scale

length scale of thermal surface patterns

scaling factor of the laminar layer depth

ratio of laminar scaling factors for heat over sea

minimal stomata resistance